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Loxosomella from *Tedania ignis*, the Caribbean Fire Sponge

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Although several species of *Loxosomella*—in fact, most of those hitherto referred to the abandoned (Nielsen, 1964) genus *Loxocalyx* Mortensen—live on the surface or in the canal systems of sponges, they are not encountered too commonly. If not particulary searched for, single specimens can be overlooked easily when one is collecting and studying sponges. In two instances, however, mass colonization of *Loxosomella* has been observed in the tropical west Atlantic on *Tedania ignis* (Duchassaing and Michelotti), the fire sponge.

While collecting sponges in April 1967, I took one specimen of *Tedania ignis* from pilings of the south boat dock of the marine biological laboratory on Magueyes Island, off La Parguera, Puerto Rico. A conspicuous, fluffy, whitish coating on the sponge surface turned out to be a dense layer of *Loxosomella bimaculata*, new species, described herein. An average of 500 specimens per cm^2 was counted, with a total of almost 100,000 specimens on a host sponge twice the size of a human fist. Strewn among them were a few dozen specimens of a taller, brownish species described herein as *Loxosomella parguerensis*, new species. The examination of other sponge species growing nearby did not reveal loxosomatids of any kind.

In December and January of 1966–67, I observed an even more impressive mass development of *Loxosomella* in Church Bay, Harrington Sound, Bermuda. The rocky littoral, with numerous, typical flame-red fire sponges, merged with a slightly sloping silty bottom in about two meters of depth, where a blackish "variety" of a similarly shaped sponge was abundant on lumps of dead coral rock. It later was discovered that these specimens were covered densely with *Loxosomella tethyae*, new species, also described herein. Between 500 and 2500 specimens were counted per cm^2, totaling about 20,000 per specimen of host sponge. No other sponge species was infested, nor was the same species infested when growing in water shallower than one meter.

METHODS.—*Loxosomella bimaculata* and *L. parguerensis* from Puerto Rico were relaxed with magnesium sulfate and then fixed in Bouin's fixative. *Loxosomella tethyae* from Bermuda could not be relaxed and was fixed directly and preserved in 4 percent formalin in sea water or 70 percent alcohol. The specimens in formalin remained in fairly natural shape; the ones in alcohol showed strong shrinkage in girth.

All measurements were made on specimens stained with Mayer's hemalum and mounted in "Preservaslide." The total length was measured from the edge of the tentacular membrane to the "toe" of the foot; calyx length, from the edge of the tentacular membrane to the lower point of the stomach; stalk length, from the lower point of the stomach to the "toe"; calyx width (stomach), at the widest part of the stomach; and calyx width (lophophore), at the widest part of the lophophore (edge of tentacular membrane). For histological sections, a celloidin-paraffin technique was used as described by Antonius (1965).

ACKNOWLEDGMENT.—I wish to thank Dr. Paul R. Burkholder, Lamont Geological Observatory of Columbia University, N.Y., who provided funds that made collections of these specimens possible.

Loxosomella bimaculata, new species

FIGURES 1–3

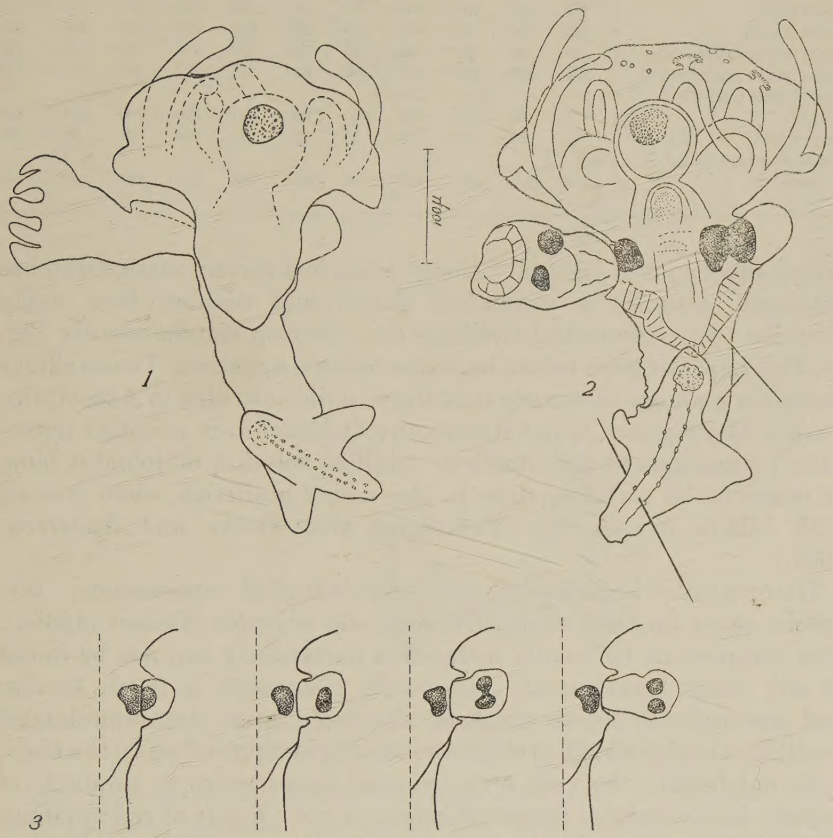
HOLOTYPE.—USNM 11928 (slide mount).

PARATYPES.—USNM 11929, USNM 11930 (slide mounts), USNM 11931 (alcohol).

LOCALITY.—Together with *L. parguerensis*, new species, on one specimen of fire sponge (*Tedania ignis*) from pilings (just below low tide level) of the south dock on Magueyez Island, off La Parguera, Puerto Rico. Collected Apr. 7, 1967.

DESCRIPTION.—Hundreds of small specimens covered the surface of the host sponge with a density of between 200 and 900 specimens

per cm². They are white (also when living) with the exception of two blackish, symmetrical, anterior swellings at the level of the budding points; hence, the specific name. Maximum total length is 650μ, the ratio of calyx length to stalk length is approximately 1 : 1. Ten long tentacles arise from the upwardly directed lophophore and are enclosed by a characteristic collar-shaped membrane. The stalk is only



FIGURES 1–3.—*Loxosomella bimaculata*, new species: 1, posterior view; 2, anterior view showing the pigmented swellings, spicules of the host sponge protruding from stalk and foot; 3, four budding stages demonstrating pigment distribution from the anterior swellings.

slightly smaller in diameter than the calyx in the region of the stomach. The foot is fleshy and provided with distinct wings. Table 1 shows comparative measurements of 11 specimens.

The nature of the anterior swellings is not clear. They are placed just above the anterolateral budding points and are covered with a dark granular pigment. They are present in all specimens, including the buds. Very young buds, when growing out of the mother animal,

TABLE 1.—*Comparative measurements (in microns) of 11 specimens of* Loxosomella bimaculata, *new species* (PR II/3=newly freed bud from PR IV/4; PR II/13=holotype)

Specimen	PR II/2	PR II/3	PR II/4	PR II/5	PR II/7	PR II/13	PR II/15	PR II/20	PR II/27	PR II/35	PR II/36
Total length	400	168	385	315	272	480	580	540	400	305	650
Calyx length	225	100	215	165	175	290	300	300	240	180	325
Calyx width (stomach)	98	58	90	68	75	125	125	115	85	68	125
Calyx width (lophophore)	220	100	237	175	200	330	310	320	254	200	318
Stalk length (including foot)	175	68	170	150	100	190	280	240	160	125	325
Stalk width	65	38	70	45	54	88	90	90	68	50	88
Tentacular membrane width	215	100	240	175	185	300	290	300	240	190	156

take a small spot of pigment "along" that, in a certain state, stretches sideward, assumes a dumb-bell shape, and divides, thus again covering two symmetrical swellings that develop simultaneously (fig. 3). This happens even before tentacles become apparent. The swellings contain a granular substance that stains uniformly blue in Azocarmin-Pasini. The pigment is not fluorescent; it bleaches in acidified potassium permanganate and stains in acidified solution of toluidin blue. It seems to be melanin, since it also reacts positively when treated with Lillie's ferrous ion. (Techniques after Barka and Anderson, 1965.)

DISCUSSION.—Because of its morphological appearance, this species must be very close to *Loxosomella cricketae* Nielsen (1966a). The conspicuous tentacular membrane particularly can not be found in any other loxosomatid. *Loxosomella bimaculata* is much smaller and has well-developed wings on the foot. Since the anterolateral swellings are pigmented so characteristically and passed on to the buds, I do not believe they are only seasonal appearances or products of certain developmental stages. Whether or not "a pair of red swellings at the anterior part of the hyposphere" (Nielsen, 1966a, p. 256) on larvae of *L. cricketae* (observed in November) are homologous remains to be proven.

Loxosomella parguerensis, new species

FIGURES 4–6

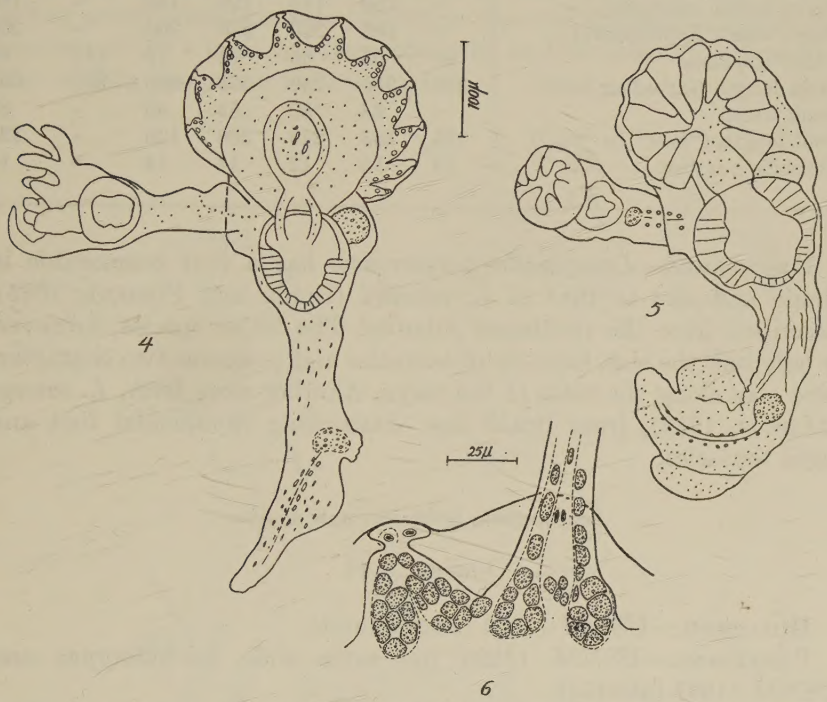
HOLOTYPE.—USNM 11932 (slide mount).

PARATYPES.—USNM 11932 (on same slide as holotype), USNM 11933 (slide), USNM 11931 (alcohol).

LOCALITY.—Together with *L. bimaculata*, on the same specimen of *Tedania ignis* from pilings (just below low-tide level) of the south

dock on Magueyez Island, off La Parguera, Puerto Rico. Collected Apr. 7, 1967.

DESCRIPTION.—Specimens of this species are of medium size, few exceeding 700μ in total length. They are brownish and occur in moderate numbers on the surface of the sponge. The calyx is only slightly shorter than the stalk. Comparative measurements of six specimens are shown in table 2.



FIGURES 4–6.—*Loxosomella parguerensis*, new species: 4, posterior view; 5, anterior view; 6, bases of two tentacles, with tentacular membrane and gland cells.

The lophophore is directed forward and bears 14 (in rarer cases only 12) long tentacles. At the base of each tentacle there are two groups of large gland cells that extend as 1-cell rows into the tentacle (fig. 6). A rather conspicuous tentacular membrane is present and is 30μ to 40μ wide. The calyx is thin and tapers gradually but strongly toward the stalk, thus having a triangular appearance. In cross section, the stalk is circular below the stomach but thicker than wide just above the "heel" of the foot. The comparatively long foot has two delicate but distinct wings and a large bean-shaped gland.

The budding points are lateral on a level with the rounded stomach. A maximum of one bud on each side was observed in April. They sit in deep pockets and have eight tentacles.

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TABLE 2.—*Comparative measurements (in microns) of seven specimens of* Loxosomella parguerensis, *new species* (PR I/5=holotype)

Specimen	PR I/1	PR I/2	PR I/3	PR I/4	PR I/5	PR I/7	PR I/8
Total length	540	555	580	625	710	490	680
Calyx length	240	200	330	300	315	240	330
Calyx width (stomach)	–	150	175	120	148	–	162
Calyx width (lophophore)	–	165	230	280	300	–	200
Calyx thickness	90	55	65	95	75	110	90
Stalk length (including foot)	300	255	250	325	295	250	350
Stalk width	–	38	80	55	43	–	88
Foot length ("heel" to "toe")	175	165	220	200	125	–	220
Tentacle number	12	12	12	14	14	–	14

DISCUSSION.—*Loxosomella parguerensis* has a foot comparable in shape and size to that of *L. teissieri* (Bobin and Prenant, 1953), described from the northeast Atlantic. The latter species, however, is only half the size, bears 8–10 tentacles and possesses two characteristic alae along the sides of the calyx. Another close form, *L. sawayi* (Marcus, 1939), from Brazil has outstanding rhomboidal foot and eight tentacles.

Loxosomella tedaniae, new species

FIGURES 7–10

HOLOTYPE.—USNM 11926 (slide mount).

PARATYPES.—USNM 11926 (on same slide as holotype) and USNM 11927 (alcohol).

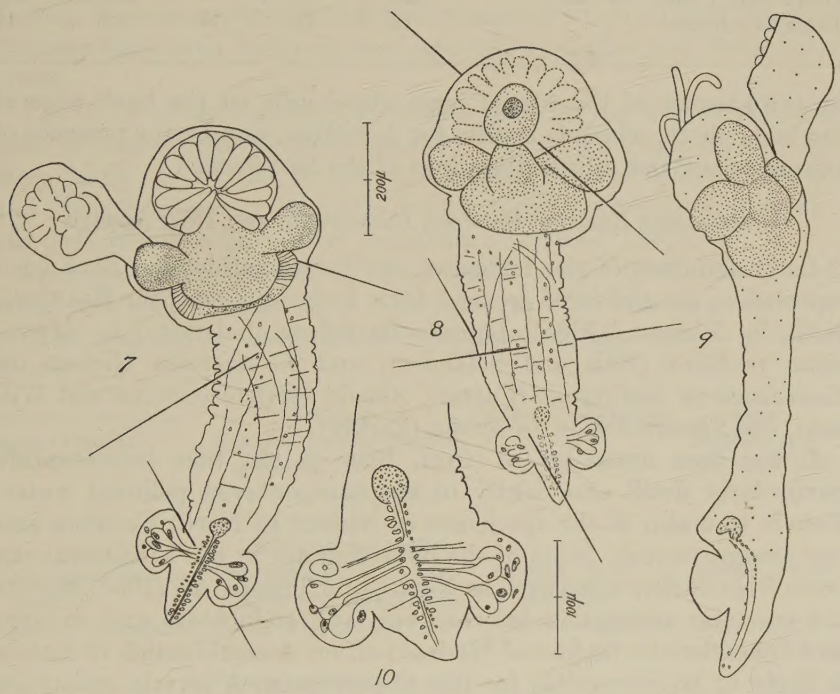
LOCALITY.—On fire sponges (*Tedania ignis*) between two and three meters deep, west flank of Church Bay, Harrington Sound, Bermuda. Collected Dec. 25, 1966.

DESCRIPTION.—Specimens rather large (total size approximately 1 mm), blackish brown, and the detritus-filled rectum appearing as a lighter spot at the back. It densely covered the surface of the host sponge, with the result that the flame-red color of the latter could not be recognized. The ratio of calyx length to stalk length is 1:3 in relaxed specimens. Table 3 shows comparative measurements of five specimens.

The lophophore points forward and bears 12 to 14 long tentacles provided with conspicuous long cilia. The calyx is flattened and almost as wide as high and tapers distinctly in the region of the stomach. The muscular stalk is about as thick as it is wide and has epithelial cells arranged in 12 to 16 longitudinal rows. The fleshy foot is pro-

vided with a large beanlike gland. There are two distinct ear-shaped lateral wings on the foot that contain several conspicuous pear-shaped glands. In stained histological sections of sponge tissue with *Loxosomella tedaniae*, a certain amount of mucus that might have originated from these glands is apparent around the foot.

The calyx, stalk, and foot of the animals are penetrated frequently by the spearlike spicules of the host sponge. The buds are formed in two anterolateral pockets just above the oval stomach. A maximum number of 2+1 buds has been observed in December. They reach a size of 750μ possessing 8–10 tentacles.



FIGURES 7–10.—*Loxosomella tedaniae*, new species: 7, frontal view; 8, posterior view, both pierced by spicules of the host sponge; 9, posterolateral view of a freshly fixed unmounted specimen; 10, frontal view of the foot with foot gland, groove, and additional glands in the wings.

DISCUSSION.—Many morphological characters of this species, particularly the comparatively long stalk, resemble *Loxosomella tethyae* (Salensky) from the Mediterranean. Nielsen (1966a) identified specimens from North Carolina as the same species. *Loxosomella tedaniae* differs from specimens from both of the above locations by its considerably smaller size [1125μ maximum in comparison to more than 2 mm (Prenant and Bobin, 1956) and 1710μ (Nielsen, 1966a)], by having 12–16 rows of epithelial cells on the stalk instead of eight,

TABLE 3.—*Comparative measurements (in microns) of five specimens of* Loxosomella tedaniae, *new species* (BE 45/6=holotype)

Specimen	BE 45/5	BE 45/6	BE 45/7	BE45/8	BE 45/10
Total length	1050	735	720	1010	1125
Calyx length	320	285	280	360	325
Calyx width (stomach)	175	300	230	240	–
Calyx width (lophophore)	275	250	250	270	–
Stalk length (including foot)	730	450	440	650	800
Stalk width	90	190	155	160	85
Foot length ("heel" to "toe")	300	–	–	240	200
Tentacle number	14	14	14	12	12

by the absence of the row of large gland cells on the back edge of the lophophore, which is typical for *L. tethyae*, and by the presence of conspicuous gland cells in the wings of the foot instead.

Interspecific Relation Between *Loxosomella* and Host Sponge

Large numbers of the following two loxosomatids also have been reported to have covered sponges from Bogue Sound, near Beaufort, N.C., by Nielsen (1966a): *Loxosomella tethyae* (Salensky) on *Microciona prolifera* (Ellis and Solander); and *L. cricketae* Nielsen on *Lissodendoryx isodictyalis* (Carter), *Adodia tubifera* (George and Wilson), and *Hymeniacidon heliophila* (Parker).

It has been noted before (Cori, 1936, p. 83) that loxosomatids particularly dwell abundantly in stagnant or even polluted water. This is true also of the specimens of Nielsen in North Carolina and the present records. Most of the older findings in the Mediterranean come from harbor areas such as Naples and Trieste. Ali (1960) reports the common association between epi- and endobionts and sponges as a characteristic feature of Madras harbor. A combination of factors is likely to be responsible for this phenomenon. A certain resistance against pollution must be assumed, and as ciliary detritus feeders, the loxosomatids find most favorable feeding conditions in rather stagnant and detritus-rich waters. Since, in such environments, the high sedimentation rate (in connection with little water movement; see Rützler, 1965, p. 71) causes burying of all suitable dead substrates or endangers survival by causing the animal to choke, sponges must prove to be the most suitable hosts. It seems practical that those species are selected (or act selective) that occur in abundance because the loxosomatid larva has a very limited dispersal range (Nielsen, 1964, p. 73). By what chemical affinities the host specifity is established and how they have evolved can not be determined in our present state of knowledge.

A combination of the above-mentioned favorable conditions and protection from natural enemies could lead to a population explosion such as the ones observed. Protection from predators might be provided by the highly toxic properties of *Tedania ignis*. Not much is known about the chemistry of the toxic substance, but it kills mice if aqueous extracts are injected intraperitoneally (Halstead, 1965, p. 275) and engraulid fishes 2 cm long are killed in less than one hour when placed in petri dishes containing 2 cc of *Tedania ignis* and 200 cc of seawater (pers. observ.). Most human beings, when handling the sponge, experience skin irritations of varying degrees. A severe erythema multiforme reaction on a man after handling *Tedania ignis* from Bermuda was reported by Yaffee and Stargardter (1963).

The only other loxosomatid so far reported to live on *Tedania ignis* is *Loxosomella vivipara* Nielsen (1966b). This species also has been found on *Ircinia fasciculata* (Pallas), *Aaptos aaptos* Schmidt, and *Chondrilla nucula* Schmidt. Among these, *Ircinia fasciculata* also has been found to have toxic properties (Halstead, 1965).

Sponge-dwelling species of *Loxosomella* never have been found associated with organisms of other groups. The following list summarizes substrate, geographical distribution, and latest detailed description:

species of Loxosomella	*host sponge*	*geographical distribution*	*source*
alata (Barrois)	*Dysidea* species (*Desidea* species) *Hymedesmia dujardini* (Bowerbank) (*Dendoryx dujardini*)	northeast Atlantic	Prenant and Bobin (1956)
bimaculata, new species	*Tedania ignis* (Duchassaing and Michelotti)	tropical west Atlantic	present paper
cochlear (Schmidt)	*Spongia officinalis* Linnaeus *Cacospongia* species	Mediterranean	Prenant and Bobin (1956)
cricketae Nielsen	*Lissodendoryx isodictyalis* (Carter) *Adocia tubifera* (George and Wilson) *Hymeniacidon heliophila* (Parker)	tropical west Atlantic	Nielsen (1966a)
lineata (Harmer)	*Halichondria* species	Indo-West Pacific	Harmer (1915)
parguerensis, new species	*Tedania ignis* (Duchassaing and Michelotti)	tropical west Atlantic	present paper
pes (Schmidt)	*Spongia officinalis* Linnaeus *Cacospongia* species	Mediterranean	Prenant and Bobin (1956)
raja (Schmidt)	*Spongia officinalis* Linnaeus	Mediterranean	Prenant and Bobin (1956)

species of Loxosomella	*host sponge*	*geographica ldistribution*	*source*
	Cacospongia scalaris Schmidt		
	Fasciospongia cavernosa (Schmidt) (*Cacospongia cavernosa*)		
sawayi (Marcus)	*Mycale* species	southwest Atlantic	Marcus (1939)
studiosorum (Toriumi)	"Monaxon Sponge"	southwest Pacific	Toriumi (1951)
teissieri (Bobin and Prenant)	*Dysidea fragilis* (Montague)	northeast Atlantic	Prenant and Bobin (1956)
tedaniae, new species	*Tedania ignis* (Duchassaing and Michelotti)	tropical west Atlantic	present paper
tethyae (Salensky)	*Tethya* [*aurantium* (Pallas)]	Mediterranean	Prenant and Bobin (1956)
	Stylotella species	tropical west Atlantic	Nielsen (1966a)
	Microciona prolifera (Ellis and Solander)		
vivipara Nielsen	*Ircinia fasciculata* (Pallas)	tropical west Atlantic	Nielsen (1966b)
	Tedania ignis (Duchassaing and Michelotti)		
	Chondrosia collectrix (Schmidt)		
	Chondrilla nucula Schmidt		

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